Earth/Mars Landing Impact Attenuation Using Foam

Completed Technology Project (2013 - 2013)

Project Introduction

Used results from extensive foam testing performed on a previous JSC Innovation Charge Account (ICA) project to develop material models in MSC/Marc commercial finite element analysis code. This will enable accurate landing impact load attenuation modeling of foam sandwiches, foam cut to match irregular shaped hardware, and foam cut in specialized shapes to customize attenuation performance. Objectives & Outcomes: * A correlated MSC/MARC material database for four popular flight / shipping foams: Polyfoam , Ethafoam, Zotek and Pyrell. A condensed list of modeling best practices. * Methodology to convert test data to MSC/MARC materials database for any foam. Infusion Potential * The database and modeling techniques may be utilized to design landing load attenuation for crew seats and other hardware in Orion; for better designed foam packaging to ship critical flight hardware to launch facilities throughout the world.

On a previous ICA, a test correlated excel based software tool was developed using the innovative Stress-Energy method to better model impact attenuation using foam. This pioneering tool was used to design packaging foam for impact attenuation of ISS flight hardware during ground shipment and of sensitive avionics in Orion parachute landing tests. The Orion project has reported no avionic damage during drop tests since the implementation of foam attenuation. This tool was limited to modeling flat foam pieces of uniform section with hardware center of gravity (CG) centered over the foam. However, the hardware being protected were not necessarily flat and many assumptions need to be made that affect accuracy of the 'G' load and foam compression estimations. Foams may be modeled using a commercial nonlinear finite element codes available at JSC such as MSC/Marc. It is proposed that results from the extensive testing done to develop the aforementioned ICA funded excel tool, now be used to develop accurate MSC/Marc material models and establish a methodology to convert test results into material models. This will enable the rapid design of foam configurations cut to match the irregular shaped hardware to be protected. Foam may be cut in pyramidical shapes to provide flexibility in designing load reduction curves to match hardware attenuation needs. Foam sandwiches may also be designed containing layers of different foam types. Attenuating Mars/Earth landing impact loads are considered critical for mission success and this technology will considerably reduce risk.

Anticipated Benefits

1. Used to model foam covered clamps for the JOTI hardware (Japanese experimental module Orbital replacement unit Transfer Interface). This is a Government Furnished Equipment project.

2. Used to develop impact absorbing foam protection for hardware returning from the International Space Station on a SpaceX Dragon spaceraft during splashdown.

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

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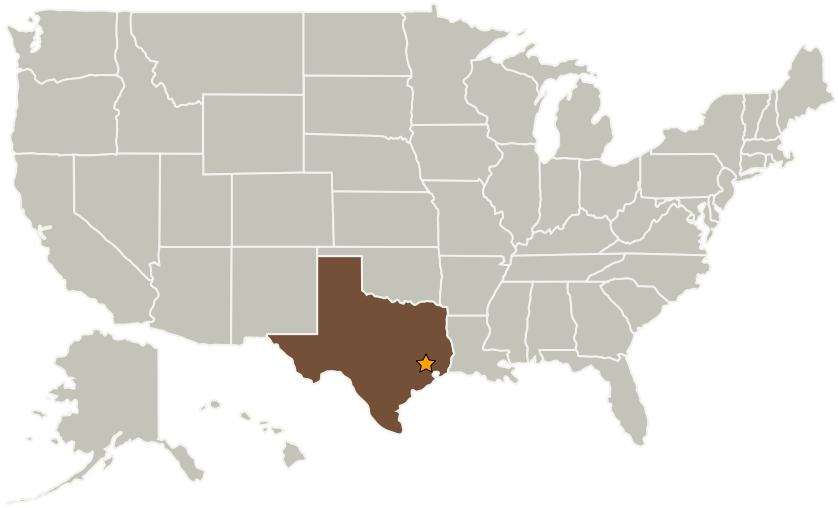
3. Used to develop impact absorbing felt covers that protect lithium ion batteries used in the personal life support system of the ISS space suit, the SAFER (the jetpack) on the space suit, hand tools that contain batteries, etc.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Jacobs Engineering Group, Inc.	Supporting Organization	Industry	Dallas, Texas

Primary U.S. Work Locations
Texas

Project Management

Program Director:
Michael R Lapointe

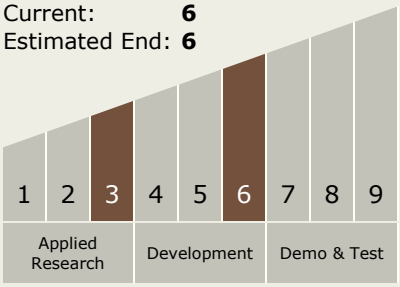
Program Manager:
Carlos H Westhelle

Project Manager:
Satish C Reddy

Principal Investigator:
Satish C Reddy

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.2 Thermal Control Components and Systems
    - TX14.2.4 Insulation and Interfaces